The International Nonproliferation Regime and IAEA Safeguards

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The Nonproliferation Regime

Immediately following the bombing of Hiroshima and Nagasaki, governments around the world considered whether they, too, should acquire nuclear arsenals. Almost as quickly, efforts began to try to limit the spread of nuclear weapons, recognizing that as the number of nuclear-armed states increases, so too does the chance of their use, intentional or accidental, and so too would additional states feel compelled to follow. Nuclear weapons were and remain unique; if a state has an arsenal, it is able to shape global politics in ways that have no parallel. Over the years, some pursued and succeeded in creating their own arsenals. A few had them and gave them up, and many came to accept that given the unique circumstances attached to nuclear weapons and the existing arsenals, their national security and the prospects for international peace and stability would be best served through forgoing national capabilities in favor of collective security arrangements.

Aum Shinrikyo and Al Qaeda have each pursued the acquisition of nuclear weapons; terrorist organizations would be more likely to use them against targeted states regardless of whether the states have or do not have nuclear arsenals. Extreme terrorist organizations have little concern for loss of life or of retribution.

All nuclear weapons employ fission energy components. The weapons may also employ fusion in boosting the energy release of the fission triggers, and may have fusion or fusion and fission secondary elements in thermonuclear weapons. All nuclear weapons require the use of certain fissile or fissionable materials, chiefly, plutonium, high-enriched uranium containing ^{235}U and/or ^{233}U, neptunium or americium.[1] Plutonium is best suited to nuclear weapons, especially when the fraction of ^{239}Pu is very high. While plutonium is best, high-enriched uranium is the easiest to use. All can produce the same levels of death and destruction. The technical knowhow on designing nuclear weapons has become more available as time has gone by; access to weapon-usable fissile (or fissionable) materials remains the key ingredient, the most difficult to come by, and hence the basis for mechanisms seeking to prevent or inhibit proliferation.

[1] Fissile nuclei fission when struck by a neutron of any energy, while fissionable nuclei will fission only if the neutron striking the nucleus has an energy above approximately 100 keV. Both can be used for nuclear weapons and the distinction is not important in this consideration.

In the 64 years since the nuclear weapons were invented, the international community has established a labyrinth of mechanisms aimed at preventing the proliferation of nuclear weapons; it continues to expand and its capabilities today would have been unimaginable in the beginning years of the nuclear era. This labyrinth goes under the rubric of the "international nonproliferation regime."

Over this 64-year period, most states have settled on a national policy; fortunately, most concluded that they have no need for a national arsenal. Of the 192 UN member states today, all but four are parties to the Treaty on the Nonproliferation of Nuclear Weapons (the NPT). Of the parties to the NPT, five are recognized as "nuclear weapon states" as they tested weapons before a deadline specified in the NPT (January 1, 1967). Some of the other NPT parties have been granted security guarantees by nuclear weapon states, and have enjoyed decades of peace without the costs and complexities of maintaining their own arsenals. A few of the NPT parties have broken their pledges to refrain from pursuing nuclear weapons in violation of the Treaty: Iraq, the People's Republic of Korea and Libya. Others – especially Iran -- are pursuing nuclear programs that appear to be inconsistent with peaceful applications of nuclear energy and remain unresolved areas of suspicion. These states are outside the mainstream of international community; they often suppress their own citizens and threaten their neighbors.

Absent any specific threats, the workings of the nonproliferation regime are aimed at solidifying the tenets and culture of nonproliferation, extending the sense of community and emphasizing the benefits of participation. The nonproliferation regime – in principle – includes all sovereign states. In a given instance, however, a state deciding to pursue nuclear weapons becomes increasingly isolated from the majority of the international community and earns regime's attention and actions.

A State intent on developing its own nuclear arsenal must develop or acquire a workable design, must obtain the necessary fissile/fissionable material, and must complete the many steps necessary to manufacture the weapon and the means chosen to deliver it (or them, as the arsenal expands) to its enemy. Figure 1 illustrates these actions with the known alternatives. Each represents a requirement for a proliferating state; each also represents a means to inhibit the success of the would-be proliferator by denying it assistance or by detecting its actions and thereby enabling appropriate interdiction.

Figure 1 represents a physical model that is used track the activities of states to determine where they stand in relation to establishing the capabilities necessary for nuclear weapons. This model, or others similar to it, is in use by governments and international organizations intent on preventing the further proliferation of nuclear weapons.

States pursuing nuclear power must satisfy legitimate requirements for nuclear fuel. Hence, any state may have wholly legitimate reasons for engaging in some of the activities shown in Figure 1. The international community, in order to make proliferation more difficult to carry off, needs to somehow balance legitimate needs with the concerns that inevitably arise as states acquire the capabilities that could serve both peaceful use and nuclear weapon manufacture. Are the needs legitimate? Is there a way to make fuel available without having more and more states develop national capabilities including the proliferation technologies?

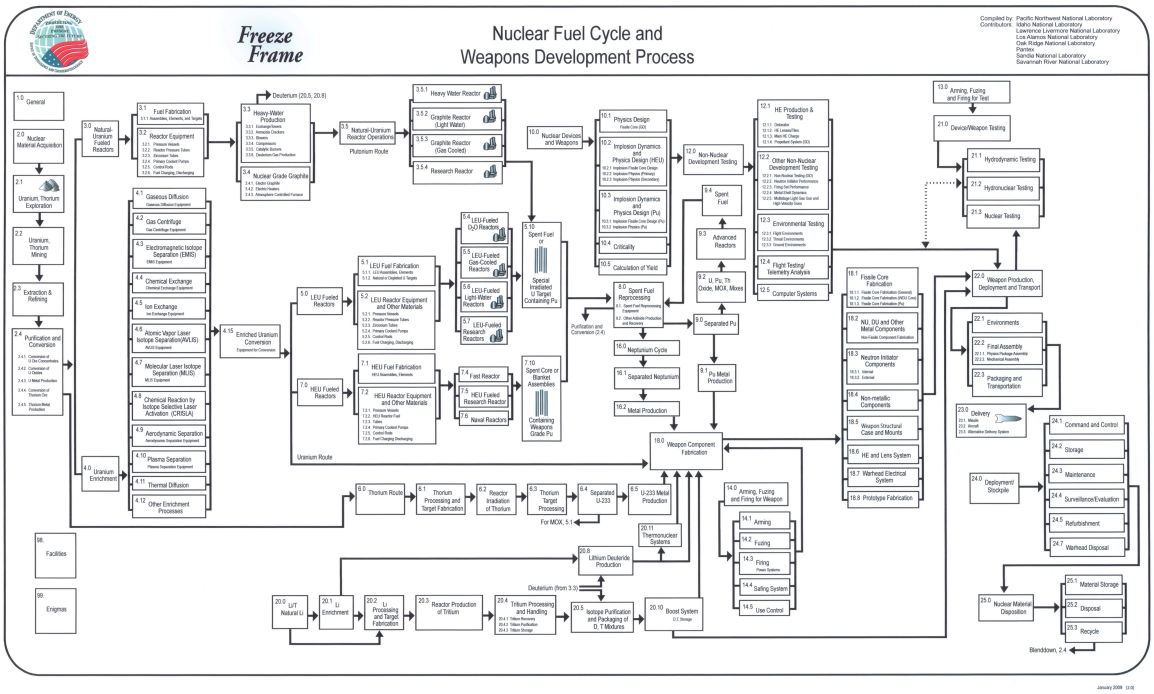

Figure 1. Nuclear Fuel Cycle and Weapons Development Flowchart.[2]

The nonproliferation regime can be defined by the interactions between the authorities that have been created, the entities that act within those authorities (or to create them) and the actions that the entities may take or actually do take. These authorities, players and activities are shown in Table 1, which presents a composite picture of the nonproliferation regime today. The nonproliferation regime has certain activities that are ongoing in nature and others that come when and as needed. No proliferation cases are identical and the interactions of the various elements in a given case depend on the states involved, the circumstances, the extent to which other actors engage and the methods and techniques they apply.

The authorities underlying the nonproliferation regime include those that a sovereign state develops for its internal use and others that it develops for use other

[2] C. Willingham, Nuclear Fuel Cycle and Weapons Development Flowchart, PNNL-SA-62579, September 2008.

states or for international organizations. Some of the authorities arise in formal diplomatic instruments (treaties, conventions, agreements). Others may be legal contracts between industrial suppliers and their customers. Still others may be in the form of agreed guidelines that participants accept (or choose to disregard, as they deem appropriate). Some are meant to encourage preferred practices, others to compel. States may accede to requirements that restrict their behavior; they may choose to participate in consensus activities, to supplement regional or international requirements with their national capabilities, or to circumvent the controls applied by others. In a given situation, multiple players may engage, sometimes operating under several complementary authorities and sometimes aimed at multiple activities.

Authority	Players	Actions
Sovereign state laws & regulations	Public	Create nonproliferation culture to diminish nuclear weapons' appeal
UN Charter, esp. Chapter VII	Sovereign State Governments, Agencies	Get States to accept binding nonproliferation commitments
Security Council Resolutions (including 1540, 687)	Regional Control Bodies (Euratom, ABACC)	Promote nuclear technology exchange minimizing proliferation risk
Proliferation Security Initiative Membership	United Nations & Security Council	Gather intelligence on nuclear activities
Treaty for the Nonproliferation of Nuclear Weapons (the NPT)	IAEA: Secretariat, Board of Governors, General Conference	Verify design information, inspect to confirm absence of diversion, clandestine production, weaponization
IAEA Statute and Safeguards Agreements, Additional Protocol	Nuclear Suppliers Group and Zangger Committee	Investigative reporting, scholarly analysis
Nuclear Suppliers Group and Zangger Committee Guidelines	Nuclear Vendors	Supplier denials to suspicious requests
Nuclear Supply Commercial Contracts	Nuclear Facility Operators	Export denials in relation to guidelines and cross notifications
Nuclear Facility Procedures & Practices	NGOs: NTI, WINS, CEIP, LNCV	Interdict illicit trafficking
Nuclear-Weapon-Free-Zone Treaties	Professional Societies: INMM, ESARDA	Diplomacy to address suspected acts of noncompliance
Fissile Material Cutoff Treaty (to be negotiated)	National Labs, Universities: MIIS, TAMU, Kennedy, Tokyo University	Sanctions
Comprehensive Test Ban Treaty (not in force)	Armed Forces	Military intervention

Table 1. The International Nonproliferation Regime: Authorities, Players, and Actions

Individual states operate as they see fit, subject to external influences. As noted, most states ascribe to international nonproliferation principles and hence form a

bloc able to support common actions. States pursuing nuclear weapons may act alone, or in some cases, may manage to gain political allies and so undermine concerted measures against their activities.

The actions taken may be positive and constructive, when attempting to create conditions to reduce future motivations. They may be of an ongoing confirmatory nature to demonstrate that states are honoring their obligations. Or they may be direct, as in confronting a state through diplomatic processes, interdicting clandestine shipments of equipment or materials useful in the manufacture of nuclear weapons, or engaging in military action to prevent the successful acquisition of nuclear weapons.

The International Atomic Energy Agency and the Nonproliferation Regime

The International Atomic Energy Agency (the IAEA) occupies a central position in the nonproliferation regime; it is considered by some to be the "cornerstone." Whatever figurative metaphor might be used, it derives its legitimacy and authority from multiple sources, it acts alone and in concert with other players, and it carries out a wide range of activities. The activities that the IAEA can engage in and the mechanisms for funding its work are spelled out the IAEA Statute.[3]

While the principal role of the IAEA in the nonproliferation regime is to carry out safeguards in accordance with safeguards agreements that commit each state and the IAEA to certain actions. As shown in the text boxes below, the Agency gains its legitimacy from the broad range of activities it performs and the reputation it enjoys, particularly in the developing areas of the world.

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Treaties including IAEA-related provisions

Treaty on the Non-Proliferation of Nuclear Weapons (NPT); Treaty for the Prohibition of Nuclear Weapons in Latin America (Tlatelolco Treaty); The African Nuclear-Weapon-Free Zone Treaty (Pelindaba Treaty) including Annexes and Protocols; and the Cairo Declaration; South Pacific Nuclear Free Zone Treaty (Rarotonga Treaty); Southeast Asia Nuclear Weapon-Free Zone Treaty (Treaty of Bangkok); Agreement between the Republic of Argentina, the Federative Republic of Brazil, the Brazilian-Argentine Agency for Accounting and Control of Nuclear Materials (ABACC) and the IAEA for the Application of Safeguards; Verification Agreement between the IAEA and the European Atomic Energy Community (EURATOM); Guidelines for Nuclear Transfers, 1993 Revision of NSG London Guidelines; Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Dumping Convention); International Convention for the Safety of Life at Sea; Convention Relating to Civil Liability in the Field of Maritime Carriage of Nuclear Materials; Treaty Banning Nuclear Weapons Tests in the Atmosphere, in Outer Space and Under Water, Partial Test Ban Treaty; Paris Convention on Third Party Liability in the Field of Nuclear Energy; Brussels Convention Supplementary to the Paris Convention; Code of Practice On the International Transboundary Movement of Radioactive Waste: The IAEA Code of Practice; Code of Conduct on the Safety and Security of Radioactive Sources and the Supplementary Guidance on the Import and Export of Radioactive Sources; Comprehensive Test Ban Treaty; Convention for the Suppression of Acts of Nuclear Terrorism.

[3] The Statute of the International Atomic Energy Agency is published by the IAEA and is available on the IAEA web site.

The Agency has also been the focal point for the negotiation of eleven conventions addressing a range of nuclear topics.

> Conventions negotiated under IAEA auspices:
> Convention on Early Notification of a Nuclear Accident; Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency; Convention on Nuclear Safety; Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management; Convention on Physical Protection of Nuclear Material; Vienna Convention on Civil Liability for Nuclear Damage; Protocol to Amend the 1963 Vienna Convention on Civil Liability for Nuclear Damage; Convention on Supplementary Compensation for Nuclear Damage Optional Protocol Concerning the Compulsory Settlement of Disputes to the Vienna Convention on Civil Liability for Nuclear Damage; Joint Protocol Relating to the Application of the Vienna Convention and the Paris Convention; Nordic Mutual Emergency Assistance Agreement in Connection with Radiation Accidents; and Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter.

In terms of the Actions identified in Table 1, the IAEA does or may participate in almost all.

Create nonproliferation culture to diminish nuclear weapons' appeal: The Agency provides a forum for ongoing discussion of nonproliferation in all of its aspects and is frequently invited to discussions or conferences on related topics, especially the United Nations and the Conference on Disarmament. As measures related to nuclear disarmament enter into force, some, like the Fissile Material Cutoff Treaty, will likely engage the IAEA in a significant role.

Get States to accept binding nonproliferation commitments: The Agency engages States that have yet to conclude their safeguards agreements and supports activities related to the Convention on the Physical Protection of Nuclear Material. The Agency supports the need for nuclear weapon states to honor their obligations in relation to Article VI of the NPT, noting the complications that lack of progress make in maintaining the viability of the NPT and the nonproliferation regime.

Promote nuclear technology exchange minimizing proliferation risk: IAEA Member States have asked the Agency to provide assistance in developing the infrastructure required for the introduction of nuclear power. The Agency carries out nuclear power analytical studies investigating the adequacy of states' preparations, carries out technical studies on nuclear power systems (including proliferation-resistant small-scale nuclear power systems), developing innovative concepts for new systems and developing nuclear fuel assurance arrangements intended to remove states' motivations for acquiring national enrichment capabilities.

Gather intelligence on nuclear activities: The IAEA does not acquire information through any means that are not approved by the Board of Governors. It does not spy, does not pay for information, does not read private communications and does

not eavesdrop on telephone or radio communications. But it does mine *open-source* information, it does make use of commercial satellite imagery, and it does make use of information made available to the Agency through its various programs. All of these are in addition to the information it obtains in the course of carrying out safeguards activities at declared nuclear sites, as noted below. The Board of Governors has approved the use of "third-party" information provided by Member States, which is conveyed on a confidential basis. The Secretariat is prohibited from providing "Safeguards Confidential" information to Member States.

Verify design information, inspect to confirm absence of diversion, clandestine production, weaponization: These are the basic functions of the IAEA safeguards system and are described in detail later in this article.

Investigative reporting, scholarly analysis: The Agency is engaged in further improvements of its activities in relation to nonproliferation. Staff members analyze diversion possibilities, develop safeguards approaches and implementation plans and think ahead on how to address arising challenges. Analyses and reports produced outside the Agency are scrutinized and staff members publish papers and participate in conferences.

Supplier denials to suspicious requests: The Agency has worked with nuclear suppliers (especially those dealing in dual-use commodities) on suspicious requests and on reporting on offers to purchase commodities that do not reflect typical peaceful use applications. This information is provided to inspectors who may pursue complementary access measures to investigate the reasons for the bogus orders.

Export denials in relation to guidelines and cross notifications: These activities are normally within the scope of activities of the Nuclear Suppliers Group and the Zangger Committee, and the IAEA has no official role in these activities. However, in the event that an export application is denied, this sort of information may be made available to the Secretariat as third party information.

Interdict illicit trafficking: This is more likely in the domain of individual states acting on information. Within the IAEA, there is an Office of Nuclear Material Security within the Department of Safety and Security, and this organization uses extrabudgetary funding to help Member States bolster their border security and to improve physical protection of nuclear installations, nuclear materials and nuclear transport.

Diplomacy to address suspected acts of noncompliance: The IAEA is unique among UN organizations in that it has the authority to refer cases to the Security Council. In recent years, however, most of the non-compliance cases could not be resolved in the Council, as the veto rights of the P5 blocked decisive action. As a result, the

Board has remained the focus of discussions on Iran and Syria, which has distracted the Agency from its normal functions.

Sanctions: The IAEA has no authority to impose the types of sanctions that could compel a state to change its activities. It is empowered to withhold or suspend technical assistance projects and presumable deny a state from full participation in the functions of the Agency. Its most potent vehicle may be condemnation and castigation.

Military intervention: The IAEA has no military capability and it would not be appropriate to suggest military action under any circumstances. However, its activities have influenced conflict, especially in Iraq at the onset of the second Gulf War.

IAEA Safeguards Implementation

Today, IAEA safeguards have two fundamental objectives and one emerging interest.

The first safeguards objective is included in the model for all IAEA comprehensive safeguards agreements in paragraph 28 of INFCIRC/153, i.e., *timely detection of diversion of significant quantities of nuclear material from peaceful use to the manufacture of nuclear weapons or other nuclear explosive devices, or for purposes unknown, and deterrence of such diversion through the risk of early detection.*[4] Safeguards carried out pursuant to this objective are aimed at verifying state declarations on facilities and flows and inventories of nuclear material. It took the better part of two decades after the entry into force of the NPT and the Agency's safeguards agreements to develop and implement a system with robust technical solutions to challenging technical problems. This part of the safeguards system is now referred to as "traditional safeguards," and accounts for on the order of 80% of all activities. As the capabilities developed, international concerns that states' might divert from declared inventories and flows were mostly satisfied. There are remaining technical challenges posed by large scale reprocessing plants due to measurement limitations. Most of the challenges are aimed at finding increased efficiencies so as to allow IAEA resources to be committed to the second objective.

Under traditional safeguards, states submit design information on their nuclear facilities and reports on inventories and inventory changes of nuclear material subject to safeguards. The Agency examines the design information and establishes a "safeguards approach" defining how the accounting system at each facility should be organized including material balance areas and key measurement points,

[4] *INFCIRC/153 (Corrected),* The Structure and Content of Agreements Between the Agency and States Required in Connection with the Treaty on the Non-Proliferation of Nuclear Weapons, IAEA, June 1972.

together with the inspection activities and equipment the Agency plans to use in order to derive independent conclusions in relation to the stated safeguards objective. Design information verification has been recognized as a critical and ongoing activity, providing assurance that the safeguards approach is tailored to each facility and that no modifications are introduced that would render it ineffective.

Number of facilities under safeguards or containing safeguarded material

Facility type	Number of facilities (number of installations)			
	Comprehensive safeguards agreements[a]	INFCIRC/66[b]	Nuclear weapon States	Total
Power reactors	186 (223)	11 (14)	1 (1)	198 (238)
Research reactors and critical assemblies	141 (152)	7 (7)	1 (1)	149 (160)
Conversion plants	13 (13)	1 (1)	— (—)	14 (14)
Fuel fabrication plants	38 (39)	3 (3)	— (—)	41 (41)
Reprocessing plants	5 (5)	1 (1)	— (—)	6 (6)
Enrichment plants	8 (8)	— (—)	2 (4)	10 (12)
Separate storage facilities	67 (68)	3 (3)	7 (8)	77 (79)
Other facilities	82 (92)	1 (1)	1 (1)	84 (94)
Subtotals	**540 (600)**	**27 (30)**	**12 (15)**	**579 (645)**
Other locations	325 (423)	3 (30)	— (—)	328 (453)
Non-nuclear installations	— (—)	1 (1)	— (—)	1 (1)
Totals	**865 (1023)**	**31 (61)**	**12 (15)**	**908 (1099)**

[a] Covering safeguards agreements pursuant to NPT and/or Treaty of Tlatelolco and other comprehensive safeguards agreements.
[b] Excluding installations in nuclear weapon States; including installations in Taiwan, China.

Source: IAEA

The IAEA makes use of defined *significant quantities*, *timeliness criteria* and prescriptive criteria considered essential for effective verification. These safeguards measures are designed so as to verify the findings of the State System of Accounting for and Control of nuclear material (the SSAC), and in this light, safeguards inspections audit state/facility records and reports and employ independent measurements to confirm individual items containing nuclear material, or batches, strata, and material balance components.

In applying traditional safeguards, the Agency makes bulk measurements of mass or volume, takes samples and has them analyzed in the IAEA Safeguards Analytical Laboratory (or in one of the Network of Analytical Laboratories). IAEA analytical chemists employ various techniques, including gravimetric and Davies/Gray procedures for uranium and isotope dilution mass spectrometry for plutonium. Radiometric nondestructive assay measurements are used extensively at the nuclear facilities, which extend the reach of measured verification and provide

optimal results for nonhomogeneous materials. Installed unattended monitoring systems are used to capture verification results without inspectors being present. Containment and surveillance systems complement nuclear materials accountancy, in some cases effectively displacing it. Remote monitoring systems are increasingly deployed as a means to provide intense data acquisition while reducing inspection costs.

IAEA Analytical Laboratory at Seibersdorf / D. Calma, IAEA.

Figure 2. IAEA laboratory analysts working on safeguards samples in a glove box at the Safeguards Analytical Laboratory.

Traditional safeguards lead to conclusions regarding material unaccounted for at each facility. The findings of each inspection are reported to the state in summary reports following each inspection, and in an annual material balance statement for each facility. All safeguards findings, including the findings of the traditional safeguards activities, are reported to the Board of Governors once each year in the Safeguards Implementation Report.

The second safeguards objective is based upon the obligations of states to "accept safeguards, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within its territory, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices," and the corresponding right and obligation of the IAEA "to ensure that safeguards will be applied, in accordance with the terms of the Agreement, on all source or special fissionable material in all peaceful nuclear activities within the territory of the State, under its jurisdiction or carried out under its control anywhere, for the exclusive purpose of verifying that such material is not diverted to nuclear weapons or other nuclear explosive devices."[5]

This is the basis for the requirement on the Agency to verify the absence of undeclared nuclear materials or activities. It was prompted by the recognition that states violating their nonproliferation undertakings would of necessity carry out some activities that should have been subjected to safeguards. The activities may in part be carried out at declared facilities, or at separate locations never announced to the IAEA. The IAEA Board of Governors instructed the Secretariat to consider the completeness of declarations made to it, and these investigations have been central to the enquiries in South Africa, DPRK, Libya, Syria and Iran, plus others. Given the

[5] INFCIRC/153, paragraphs 1 and 2.

relative success of the Agency's traditional safeguards system, it is more likely that if a state were to pursue nuclear weapons, it would take benefit of its declared facilities as a means to prepare itself, but would likely proceed with clandestine operations separate from its safeguarded installations.

By their very nature, traditional safeguards confirm state reports and design information at declared facilities. Clandestine activities may involve the misuse of declared facilities or be carried out anywhere within the territory of the state or under its jurisdiction.

There are two elements of the traditional safeguards system that provide authority for the Agency to carry out activities seeking information on possible clandestine activities. The first is design information verification, a continuing right of the Agency to verify that all operations and materials used in declared facilities are as declared. The Agency exercises this right all the more so since the Board of Governors clarified this in relation to the efforts to strengthen the safeguards system as its limitations became evident.[6] This authority is limited to declared facilities, which could compel a state intent on violating its nonproliferation obligations to avoid the misuse of its peaceful facilities on the risk of being found out.

The second is the provision for special inspections under paragraph 73(b) of INFCIRC/153,

> *The Agreement should provide that the Agency may make special inspections subject to the procedures laid down in paragraph 77 below:*
>
> *(a) In order to verify the information contained in special reports; or*
>
> *(b) If the Agency considers that information made available by the State, including explanations from the State and information obtained from routine inspections, is not adequate for the Agency to fulfil its responsibilities under the Agreement. An inspection shall be deemed to be special when it is either additional to the routine inspection effort provided for in paragraphs 78--82 below, or involves access to information or locations in addition to the access specified in paragraph 76 for ad hoc and routine inspections, or both.*

This latter provision clearly extends the reach of safeguards to include the scope of the obligations of a state under paragraph 1 of its safeguards agreement. However, the one time when this mechanism was fully implemented with the approval of the Board of Governors, the state, DPRK, refused to allow the inspection, the Security

[6] IAEA Document GOV/2554, 1 April 1992.

Council was unable to agree on concrete actions and today, 17 years later, the issue remains unresolved. Rather than reinforce the role of special inspections, the Director General requested and the Board approved an "additional protocol" to the safeguards agreements on the understanding that special inspections would henceforth be used only in rare occasions.[7] Twelve years later, as of 19 May 2009, the IAEA reports that additional protocols for a total of 131 states have been approved by the Board of Governors, of which 122 have been signed by the states and 91 have entered into force. The additional protocol for the Euratom States has also entered into force.[8] The additional protocol clearly provides the Agency with greater – and easier – access to information and locations, complementing other elements of the safeguards system. But some of the states where suspicions remain have not concluded additional protocols, and several states continue to block any sense of defining the additional protocol as an essential part of a comprehensive IAEA safeguards agreement.

Compared to the traditional safeguards system, looking for hidden facilities and materials requires a different basis for implementation and different tools and techniques. Key to Agency success in this area are the following:

Satellite imagery from commercial suppliers is used by the Agency to understand the structures and activities carried out at declared sites, and to obtain information related to locations that are not declared nuclear facilities. The first use of satellite imagery was in relation to undeclared structures at the Nyonbyon site in the People's Republic of Korea. Today, the IAEA has a staff unit responsible for obtaining and analyzing satellite imagery, providing a remarkable capability used when suspicions are first raised regarding specific locations, and as a means to track developments at key locations.

[7] INFCIRC/540, Model Protocol Additional to the Agreement(s) between States and the International Atomic Energy Agency for the Application of Safeguards, 1997.

[8] www.iaea.org/OurWork/SV/Safeguards/sg_protocol.html, accessed 16 June 2009.

Figure 3. On the left is a clandestine production reactor in Syria. The same site is shown on the right following bombing by Israeli planes and removal by Syria of all site debris.[9]

Environmental sampling methods are used in IAEA safeguards to detect the presence of minute amounts of nuclear material from locations within declared nuclear facilities, at declared nuclear installations and elsewhere.[10] Two techniques are employed: bulk analyses, when maximum sensitivity is needed to discover whether any anomalous conditions exist; and particle analyses, when the characteristics and composition of individual particles is needed to isolate and characterize multiple anomalies or to determine the morphology of the particles. Environmental sampling has been of fundamental importance in providing information relating to suspicions in the DPRK, Iran and Syria, for example.

Figure 4. A technician at the IAEA Clean Laboratory for Safeguards at Seibersdorf, Austria, examines uranium particles using an optical microscope. Source: IAEA.

Information received from third parties that raise questions regarding the activities underway within a state, which may result from various parties, including:

- Opposition political groups within a state;
- Information from vendors of nuclear or dual-use equipment or materials on suspicious inquiries;
- Information on denials of export applications from suspicious parties; and
- Intelligence information obtained using national technical means.

The emerging interest is *weaponization*. If the Agency were able to provide evidence that a state is actively pursuing the development or acquisition of capabilities needed to transform a nuclear explosive into a military weapon, whether focused on the warhead or on a suitable delivery system, the international community would want to know. Whether nuclear material is involved or not, the Agency should not make conclusions regarding diversion of declared nuclear materials or the absence of unreported activities or materials if it obtains such information. The nexus is clear in the safeguards objective: "… to the manufacture of nuclear weapons … ;" if weapons work is underway, it is unequivocal that efforts are or will be made to acquire the necessary nuclear material, hence, early

[9] Digital Globe ISIS, published in Washington Post, www.washingtonpost.com, accessed 16 June 2009.

[10] INFCIRC/540 foresees the possible introduction of wide-area environmental sampling, when determined to be feasible and upon approval of the IAEA Board of Governors. See INFCIRC/540, Article 9.

notification to the Board of Governors and perhaps to the Security Council provides the basis for intervention.

The Director General has provided information on weaponization activities in Iran.

The Nonproliferation Regime and the Global Expansion of Nuclear Power

The nuclear dilemma – military and peaceful use – provides a necessity unique to mankind. Mankind's perceived needs to order universal activities is not new to nuclear weapons:

> *"By A.D. 1100, the square-headed, armor-piercing quarrel had become commonly available and the crossbow was being used in Europe to shoot down knights. To a political and social structure welded together with chivalric fighting skills acquired at great cost, such a development could only prove ominous.*
>
> *Once again the Church stepped into the breach, with the second Ecumenical Lateran Council outlawing the use of the crossbow among Christians in 1139. As perhaps man's first overt attempt at arms control, the edict deserves more attention than it usually receives. In particular, its effort to enforce weapons symmetry and what amounted to technological status quo would prove characteristic of arms control in the future."*[11]

Preventing nuclear catastrophe requires three unique solutions. First, that existing nuclear arsenals are never used. Second, that the number of nuclear-armed states not grow in the future, but should shrink, eventually to zero. And third, no terrorist organization should ever be able to acquire nuclear weapons or nuclear explosives, through any means.

Since their initial use in World War II, there has never been a second use of nuclear weapons in conflict: they have been lost, fallen in accidents, transported unknowingly; their use has been threatened, and grave concerns have and remain that the lines of restraint might again be crossed. There is no nuclear disarmament regime, and notwithstanding the obligations of "each of the Parties" to the NPT, there are no binding commitments of the NPT nuclear weapon states to act, only the rising prospect of negotiations on a fissile material cutoff treaty in the Conference on Disarmament and renewed calls for bringing the Comprehensive Test Ban Treaty into force.

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[11] R. L. O'Connell, **Of Arms and Men**, Oxford University Press US, 1990
ISBN 0195053605, 9780195053609.

Efforts to prevent nuclear terrorism are viewed as the sovereign responsibility of individual states. They are reluctant to share physical security information, out of concerns that critical information might find its way to terrorists. The Convention on the Physical Protection of Nuclear Material provides a limited framework, and INFCIRC/225 provides guidelines, but anything further rests solely on voluntary participation.

IAEA activities carried out by the Department of Safety and Security cover nuclear and radioactive materials, as well as nuclear installations. The focus is on helping States prevent, detect, and respond to terrorist or other malicious acts - such as illegal possession, use, transfer, and trafficking - and to protect nuclear installations and transport against sabotage.[12] These activities are supported by voluntary contributions, their importance and acceptability has been gaining advocates and at some point this area will likely be transferred to the regular budget.

In the last year, the World Institute for Nuclear Security was established "to help secure all nuclear and radioactive materials so that they cannot be utilised for terrorist purposes, and to provide an international forum for those accountable for nuclear security to share and promote the implementation of best security practices."[13]

This article has focused on the nonproliferation regime. It is by far the most robust and pervasive than international efforts to address existing arsenals or nuclear terrorism. As illustrated in Table 1, it is based on diverse authorities, engages a host of entities and produces a range of actions, depending on circumstances. It remains a work in progress as any reading of current events demonstrates.

It is the collective performance of the nonproliferation regime that is and will remain critical for nuclear power to flourish while avoiding nuclear catastrophe. The role and expected performance of each element as seen through each sovereign state should determine missions, funding and authorities. Table 1 provides a basis for determining any gaps and the needed capabilities for each element.

The global expansion of nuclear power will empower new states with facilities and materials that some may turn to in the hopes of acquiring a nuclear capability. As new states acquire nuclear power, most are likely to embrace the concerns underlying the nonproliferation regime and increasing the number of stakeholders will strengthen the regime itself. But some may not.

[12] www.iaea.org, accessed 17 June 2009.
[13] www.wins.org, accessed 17 June 2009.